

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:
capacitor structures, each having a first lower
electrode, a first insulating film formed on the first
5 lower electrode and a first upper electrode formed on
the first insulating film; and
electric fuse elements, each having a second lower
electrode, a second insulating film formed on the
second lower electrode and having an impurity
10 concentration higher than that of the first insulating
film, and a second upper electrode formed on the second
insulating film, the electric fuse elements having
substantially same structure as that of the capacitor
structures and being formed on same level as that of
15 the capacitor structures, wherein information is
written in the electric fuse element depending on
whether the second insulating film is dielectrically
broken down, and a writing voltage of the electric fuse
element is determined by dielectric breakdown
20 resistance of the second insulating film which depends
on the impurity concentration of the second insulating
film.

2. A semiconductor device comprising:
capacitor structures, each having a first gate
25 insulating film formed on a semiconductor substrate of
a first conductivity type, and a first gate electrode
formed on the first gate insulating film; and

electric fuse elements, each having a second gate
insulating film formed on the semiconductor substrate
and having an impurity concentration higher than that
of the first gate insulating film, and a second gate
5 electrode formed on the second gate insulating film,
wherein information is written in the electric fuse
element depending on whether the second gate insulating
film is dielectrically broken down, and a writing
voltage of the electric fuse element is determined by
10 dielectric breakdown resistance of the second gate
insulating film which depends on the impurity
concentration of the second gate insulating film.

3. The semiconductor device according to claim 2,
further comprising an impurity diffusion layer of
15 a second conductivity type, which is formed in at least
a portion of the semiconductor substrate and which
abuts on the second gate insulating film under the
second gate electrode, the impurity diffusion layer
being paired with the second gate electrode and serving
20 as one electrode of the electric fuse element.

4. The semiconductor device according to claim 3,
further comprising a leading electrode electrically
connected to an extended portion of the impurity
diffusion layer extending to a region of the
25 semiconductor substrate where no second electrode
exists.

5. The semiconductor device according to claim 2,

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wherein the first gate insulating film and the first gate electrode constitute a part of a MOS transistor.

6. A method for fabricating an electric fuse comprising the steps of:

5 forming an insulating film on a first electrode;
 forming a second electrode on the insulating film;
and

10 injecting by ion injection an impurity into at least a portion of the insulating film or passing the impurity therethrough, thereby controlling dielectric breakdown resistance of the insulating film to set a writing voltage.

7. A method for fabricating a semiconductor device comprising the steps of:

15 forming a gate insulating film on first and second regions of a semiconductor substrate of a first conductivity type;

 forming a first gate electrode layer on the gate insulating film; and

20 injecting by ion injection an impurity into a portion of the gate insulating film on the second region of the semiconductor substrate, thereby controlling dielectric breakdown resistance of the gate insulating film on the second region to set a writing
25 voltage of an electric fuse comprising the second region of the semiconductor substrate, the gate insulating film located on the second region and

the portion of the first gate electrode layer on the second region.

8. The method according to claim 7, further comprising the steps of:

5 after the step of injecting the impurity into the gate insulating film, forming a second gate electrode layer on the first gate electrode layer; and

10 patterning the first and second gate electrode layers, thereby forming a gate electrodes of a MOS transistor on the first region of the semiconductor substrate and electric fuses of a capacitor structure, each having the semiconductor substrate, the gate insulating film and the first and second gate electrode layers on the second region.

15 9. The method according to claim 7, further comprising the steps of:

after the step of forming the first gate electrode layer, forming a second gate electrode layer on the first gate electrode layer; and

20 patterning the first and second gate electrode layers, thereby forming gate electrodes of MOS transistors on the first region of the semiconductor substrate, and electric fuses of a capacitor structure, each having the semiconductor substrate, the gate
25 insulating film and the first and second gate electrode layers on the second region.

10. The method according to claim 9, wherein

the step of injecting the impurity into the gate insulating film comprises the steps of:

5 injecting by ion injection an impurity of a second conductivity type into the gate insulating film located on the second region of the semiconductor substrate and into the second region of the semiconductor substrate that has been exposed by patterning the first and second gate electrode layers, thereby forming an impurity diffusion layer in a surface region of the semiconductor substrate; and

10 forming a leading electrode electrically connected to the impurity diffusion layer.

11. The method according to claim 10, wherein in the step of forming the impurity diffusion layer in the surface region of the semiconductor substrate,

15 the impurity diffusion layer is also formed in a portion of the semiconductor substrate immediately under the first and second gate electrode layers located on the second region.

20 ~ 12. A method for fabricating a semiconductor device comprising the steps of:

forming a gate insulating film on first and second regions of a semiconductor substrate of a first conductivity type;

25 forming a first gate electrode layer on the gate insulating film; and

injecting an impurity into the second region of

the semiconductor substrate in contact with the gate
insulating film by ion injection through the first gate
electrode layer and the gate insulating film on the
second region of the semiconductor substrate, thereby
5 forming an impurity diffusion layer, controlling
dielectric breakdown resistance of the gate insulating
film on the second region to set a writing voltage of
an electric fuse comprising the second region of the
semiconductor substrate, the gate insulating film
10 located on the second region and the first gate
electrode layer located on the second region.

13. The method according to claim 12, further
comprising the steps of:

after the step of injecting the impurity into
15 the second region of the semiconductor substrate
through the first gate electrode layer and the gate
insulating film, forming a second gate electrode layer
on the first gate electrode layer; and

patterning the first and second gate electrode
20 layers, thereby forming gate electrodes of MOS
transistors on the first region of the semiconductor
substrate, and electric fuses of a capacitor structure,
each having the semiconductor substrate, the gate
insulating film and the first and second gate electrode
25 layers on the second region.

14. The method according to claim 13, wherein
the step of patterning the first and second gate

electrode layers comprises the steps of:

removing the first and second gate electrode layers located on a portion of the second region of the semiconductor substrate, thereby exposing a surface of the impurity diffusion layer; and

forming a leading electrode electrically connected to the exposed impurity diffusion layer.

15. The method according to claim 12, further comprising the steps of:

after the step of forming the first gate electrode layer, forming a second gate electrode layer on the first gate electrode layer; and

patterning the first and second gate electrode layers, thereby forming gate electrodes of MOS transistors on the first region of the semiconductor substrate, and electric fuses of a capacitor structure, each having the semiconductor substrate, the gate insulating film and the first and second gate electrode layers on the second region.

16. The method according to claim 15, wherein the step of injecting the impurity into the second region of the semiconductor substrate through the first gate electrode layer and the gate insulating film comprises the steps of:

injecting by ion injection an impurity of a second conductivity type into the semiconductor substrate in contact with the gate insulating film located under

the first and second gate electrode layers and into
the second region of the semiconductor substrate that
has been exposed by patterning the first and second
gate electrode layers, thereby forming an impurity
5 diffusion layer in a surface region of the
semiconductor substrate; and

forming a leading electrode electrically connected
to the impurity diffusion layer.

17. A method for fabricating a semiconductor
10 device comprising the steps of:

forming a gate insulating film on first and second
regions of a semiconductor substrate;

forming a first gate electrode layer on the gate
insulating film;

15 patterning the first gate electrode layer, thereby
forming gate electrodes of MOS transistors on the first
region of the semiconductor substrate, and electric
fuses of a capacitor structure, each having the
semiconductor substrate, the gate insulating film and
20 the first gate electrode layer on the second region;
and

injecting by ion injection an impurity from
a direction obliquely with respect to a normal of
the semiconductor substrate into a portion of the
25 semiconductor substrate exposed by patterning the first
gate electrode layer and a portion of the semiconductor
substrate immediately under an edge portion of

the first gate electrode layer in the second region,
thereby forming an impurity diffusion layer serving as
one electrode of an electric fuse, the ion injection
causing the impurity to pass through the gate
5 insulating film or to be injected into the gate
insulating film, thereby controlling dielectric
breakdown resistance of the gate insulating film to set
a writing voltage of the electric fuse.

10 18. The method according to claim 17, further
comprising the step of, after the step of forming the
first gate electrode layer, forming a second gate
electrode layer on the first gate electrode layer.

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